

Management of Grain Discoloration of Rice with Solvent-Free EC Formulations of Neem and Pungam Oils

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Neem and pungam oil-based emulsifiable concentrate (EC) formulations developed at Tamil Nadu Agricultural University were evaluated for their efficacy to inhibit the mycelial growth of the fungi *Helminthosporium oryzae* and *Pyricularia oryzae* causing grain discoloration on rice under *in vitro* conditions. All three formulations, *viz.*, neem oil 60 EC (acetic acid), neem oil 60 EC (citric acid) and neem oil + pungam oil 60 EC (citric acid), inhibited mycelial growth of the pathogens; they were effective even after 9 months of storage. These formulations effectively controlled the grain discoloration on rice.

KEY WORDS: Grain discoloration; neem oil; pungam oil; disease control; EC formulations.

Rice (*Oryza sativa* L.) suffers from a number of fungal, bacterial and viral diseases. Among the fungal diseases grain discoloration is one of the major limiting factors in rice production and is caused by *Cochliobolus miyabeanus* (*Helminthosporium oryzae*, *Drechslera oryzae*), *Drechslera* sp., *Pyricularia oryzae*, *Alternaria padwickii*, *Gibberella fujikuroi*, *G. zae*, *Nigrospora* spp., *Epicoccum* spp., *Curvularia* spp., *Phoma sorghina*, *Alternaria* spp. and *Helicoverpa oryzae* (12). Several methods have been used for the control of diseases and among them chemical control has been the most widely adopted in many countries. However, indiscriminate use of various plant protection chemicals has caused environmental hazards and it is preferable to find alternate sources (15). The last two decades have witnessed a tremendous interest in investigations of botanicals as sources of pest control materials and as possible alternatives to chemical fungicides (5,11). Neem has emerged as a prominent plant species having potential pesticidal properties among several such plant species known to mankind. The ingredients of neem have been well documented for their

efficacy in controlling crop diseases (6,7,13,14). Pungam leaf extract inhibited spore germination and mycelial growth of rice brown spot pathogen, *Drechslera oryzae* (2).

Even today, many workers in India and other developing countries are using leaf, seed kernel or cake extracts and oils as such for crop pest management. Preparation of these materials is time-consuming and moreover, oils as such cannot be stored for a long time because of the possible development of rancidity, leading to reduction in their efficacy. An EC formulation in which neem and pungam oils could maintain their efficacy for a considerable length of time would be ideal in the management of crop diseases. Furthermore, such a preparation would be easily miscible in water before spraying. In the present study we tested EC formulations of neem oil (NO) and pungam oil (PO), developed jointly by the Departments of Plant Pathology and Agricultural Entomology, TNAU, Coimbatore. The effects of these formulations on sheath rot disease of rice and its causative agent, *Sarocladium oryzae*, have been investigated previously (10). In the present work we investigated

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these formulations for their efficacy in inhibiting the growth of *Helminthosporium oryzae* and *Pyricularia oryzae*, the major fungal pathogens causing grain discoloration of rice, under *in vitro* conditions at periodic intervals after preparation (shelf life), and demonstrated their efficacy in controlling grain discoloration of rice under field conditions.

One isolate each of *H. oryzae* and of *P. oryzae* was obtained from infected rice grains using a potato-dextrose agar medium. The three formulations used, NO 60 EC (A=acetic acid), NO 60 EC (C=citric acid) and NO+PO 60 EC (C) as well as their testing for shelf life at fixed intervals, have been described in detail previously (10). Laboratory evaluation of the formulations was done as described previously (11).

Three field trials were conducted: one at the Paddy Breeding Station, Coimbatore,

Tamil Nadu (India) during Kharif (July–October) 1996; and two at the Rice Research Station, Tirur, Tamil Nadu during the Kharif and Rabi (November–March) seasons of 1996-97. The cultivars used were Co-43 at Tirur and IR-50 at Coimbatore. Plot size was 5m x 3m with four replications per treatment in a randomized block design. The formulations were sprayed at 3% at 10-day intervals from panicle initiation to maturity, for a total of four sprayings; plants sprayed at the same time with 0.1% carbendazim served as a standard check, and plots without any spray were maintained as control. Observations on disease incidence were made one week after the last spray by selecting 25 hills at random from each plot and rating individual panicles on a 0–9 scale (1). Percent disease incidence (PDI) was calculated using the formula (8):

$$\frac{\text{sum of all numerical ratings}}{\text{number of observations}} \times \frac{100}{\text{maximum disease rating}} \quad (1)$$

The PDI values underwent arcsine transformation. The data were analyzed statistically using Duncan's multiple range test (DMRT) (3).

In laboratory evaluations all three EC formulations significantly inhibited the mycelial growth of *H. oryzae* and *P. oryzae* (Table 1). The growth of *H. oryzae* was considerably reduced by NO+PO 60 EC (C). We recorded a radial mycelial growth of 2.8, 2.6, 3.0, 2.2 and 2.6 cm as against 8.8–9.0 cm in control at 0, 60, 120, 180 and 270 days of storage, respectively. The growth of *H. oryzae* in plates incorporated with a freshly prepared formulation NO 60 EC (A) (0 day of storage) and a formulation stored up to 9 months was 5.4 and 5.2 cm, respectively, as against 9.0 and 8.8 cm in the control. NO 60 EC (A) inhibited the growth of *P. oryzae* more effectively than the two other formulations, *viz.*, NO 60 EC (C) and NO+PO 60 EC (C); we registered for NO 60 EC (A) radial mycelial growth of 2.0, 1.8, 2.1, 2.2 and 1.9 cm as against 2.6–2.8 cm for NO 60 EC (C) and 2.8–3.0 cm for NO+PO 60 EC (C), respectively, at 0, 60, 120, 180 and 270 days of storage. Control values ranged from 8.4 to 8.6 cm.

In the field trial at Coimbatore (Table 2),

NO+PO 60 EC (C) significantly reduced grain discoloration, with the minimum PDI of 2.1 as against 5.6 in control. The PDI recorded by NO 60 EC (A) was 3.0 and it was comparable with NO 60 EC (C) and carbendazim. At Tirur, during Kharif season NO 60 EC (C) showed the lowest PDI of 3.9, which was on par with the effect of NO 60 EC (A), whereas NO+PO EC (C) was not significantly different from the control. During Rabi season at Tirur, the minimum PDI of 10.6 was registered by NO 60 EC (C) and it was on par with NO 60 EC (A) and NO+PO 60 EC (C). There was no significant difference between the PDI recorded for carbendazim and control during Rabi season at Tirur.

Antifungal properties have been demonstrated in different parts of various plants, *viz.*, leaves, seeds, cakes, etc., but it is difficult to use them for large-scale field application since their preparation takes a long time. Moreover, leaf or seed extracts cannot be stored for long periods. In the present investigation, EC formulations of neem and pungam oils retained their efficacy against *H. oryzae* and *P. oryzae* under *in vitro* conditions even after 9 months of storage. Inhibition of *S. oryzae* by neem leaf

extract and of *Drechslera oryzae* by pungam leaf extract (2), and control of rice sheath rot with neem oil and neem kernel cake extract applied to the foliage (4,9), along with reduction in disease incidence and increase in yield (9), have been reported. In the present study neem and pungam oil-based EC formulations effectively checked grain discoloration of rice. The efficacy of these formulations was superior to that of the commercially used fungicide, carbendazim. The effectiveness of these formulations pertains to material based on neem or pungam oil, but they contain additional materials which might

be biologically active, like soap, citric acid and acetic acid. The novelty of the present study consists in demonstrating the efficacy of EC formulations of neem and pungam oils both *in vitro* and *in vivo* – in field experiments – against *H. oryzae* and *P. oryzae*, the major pathogens of grain discoloration disease on rice. Unlike the chemical pesticides, these formulations are eco-friendly and easily biodegradable; moreover, they retained their efficacy even after 9 months of storage, which deserves consideration for commercial production.

TABLE 1. Effect of EC formulations of neem oil (NO) and pungam oil (PO) on radial growth of *Helminthosporium oryzae* (*H.o.*) and *Pyricularia oryzae* (*P.o.*) and their shelf-life

| Age of the formulation in storage (days) | Mycelial growth (cm) | | | | | | | | | |
|--|----------------------|-------------|--------------|-------------|-----------------|-------------|-------------|-------------|-------------|-------------|
| | NO 60 EC (A) | | NO 60 EC (C) | | NO+PO 60 EC (C) | | Carbendazim | | Control | |
| | <i>H.o.</i> | <i>P.o.</i> | <i>H.o.</i> | <i>P.o.</i> | <i>H.o.</i> | <i>P.o.</i> | <i>H.o.</i> | <i>P.o.</i> | <i>H.o.</i> | <i>P.o.</i> |
| 0 | 5.4c | 2.0b | 4.4bc | 2.7ab | 2.8c | 3.0b | 0.7a | 0.7a | 9.0b | 8.4a |
| 60 | 5.3bc | 1.8a | 4.2a | 2.6a | 2.6b | 2.9ab | 0.7a | 0.7a | 8.8a | 8.5a |
| 120 | 5.0a | 2.1bc | 4.3ab | 2.7ab | 3.0d | 2.8a | 0.7a | 0.7a | 8.9ab | 8.4a |
| 180 | 5.5d | 2.2c | 4.3ab | 2.8b | 2.2a | 2.8a | 0.7a | 0.7a | 8.9ab | 8.6b |
| 270 | 5.2b | 1.9ab | 4.5c | 2.8b | 2.6b | 2.9ab | 0.7a | 0.7a | 8.8a | 8.6b |

Within columns, means followed by a common letter do not differ significantly ($P=0.05$) according to Duncan's Multiple Range Test.

TABLE 2. Effect of neem oil (NO) and pungam oil (PO) emulsions on grain discoloration in rice

| Treatments | Percent disease incidence | | |
|-------------------------|---------------------------|------------------|----------------|
| | Coimbatore | Tirur | Tirur |
| | Kharif (1996) | Kharif (1996-97) | Rabi (1996-97) |
| NO 60 EC (A) 30 ml/l | 3.0 (9.97)b | 4.2 (11.0)a | 11.1 (19.01)a |
| NO 60 EC (C) 30 ml/l | 3.0 (9.97)b | 3.9 (11.4)a | 10.6 (18.7)a |
| NO+PO 60 EC (C) 30 ml/l | 2.1 (8.33)a | 9.8 (18.2)bc | 12.3 (20.25)a |
| Carbendazim 1 g/l | 3.2 (10.30)b | 7.8 (16.2)b | 18.0 (24.98)b |
| Control | 5.6 (13.69)c | 12.6 (20.25)c | 18.5 (23.86)b |

Within columns, means followed by a common letter do not differ significantly ($P=0.05$) according to Duncan's Multiple Range Test. Data in parentheses are arcsine transformed values.

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